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ABSTRACT

Building on previous research on the future skill needs of workers in southeastern Wisconsin, a study was conducted at Milwaukee Area Technical College (MATC) to gather information on the machine tool industry in the Milwaukee area. Interviews were conducted by MATC Machine Shop and Tool and Die faculty with representatives from 135 machine shops, ranging in size from those employing less than 10 operators to those employing over 100 operators. The interviews focused on the nature of the machine tools currently used and projected to be used in 5 years, current and projected employment figures, and the skills that MATC students should have to prepare them for work in machine shops in 1989. Study findings included the following: (1) machine shops of all sizes were evolving toward greater use of computer-controlled machines, with the larger shops currently using more of these machines and projecting greater needs for employees with skills in operating this equipment; (2) the smaller shops appeared to be more optimistic about growth, projecting an increase of 43% in the number of machine tool operators on conventional machines in the next 5 years and an increase of 363% in operators on computer-controlled machines; and (3) respondents indicated a need for employees who could operate multiple machine tools and who had some exposure to computerized operations. Recommendations for program development and information on specific skill needs of employers are included in the report. (HB)

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MATC MACHINE SHOP '84

SPECIFIC SKILL NEEDS ASSESSMENT IN THE MILWAUKEE AREA

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JC 840 400

Prepared by the

Department of Research, Planning, and Development

In Cooperation with the

Machine Shop Department in the Industrial Division, MATC

April 1984

SPECIFIC SKILL NEEDS ASSESSMENT FOR MACHINE SHOPS IN THE MILWAUKEE AREA

March 1984

Keith J. Roberts
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Prepared by
The Office of Research, Planning, and Development

In Cooperation with
The Machine Shop Department in the Industrial Division

MATC

EXECUTIVE SUMMARY

During the spring of 1983 a Future Skill Needs Assessment was commissioned by Milwaukee Area Technical College (MATC) to be used for planning purposes. Recommendations concerning Tool and Die, Machinist, and NC were included in this report. The report was meant to stimulate discussion and further research. This Specific Skill Needs Assessment for Machine Shops in the Milwaukee Area is a report of specific research conducted as a result of the original report.

The research was coordinated by the MATC Office of Research, Planning, and Development and the actual interviewers were Machine Shop and Tool and Die faculty. The results are important because they represent 135 face-to-face interviews in which all participants had in-depth knowledge of machine tools.

The original Future Skill Needs Assessment presented information that was generally accurate for larger shops. The Specific Skill Needs Assessment for Machine Shops in the Milwaukee Area presents information concerning Machine Shops of all sizes. These are important considerations for future planning. There are two key trends in the Machine Shops in the Milwaukee area:

1. All machine shops are evolving toward more use of CNC. The larger shops are evolving faster because they can afford the high cost of new equipment.

2. The smaller shops appear to be more optimistic about growth. Several respondents indicated that there will be a decrease in opportunity in larger, union shops and a corresponding increase in opportunities in smaller, non-union shops.

Overall there is a future need for a versatile machine tool operator with some exposure to CNC. The Machine Shop and Tool and Die faculty have made specific recommendations based upon a thorough analysis of this research data. These recommendations are contained in Section XIV of this report.

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I. Introduction

During the spring of 1983 a study was commissioned by the MATC Division of Economic Development to determine the future skill needs of workers in southeastern Wisconsin. This Future Skill Needs Assessment was conducted by Human Resource Services and presented information from 39 metropolitan firms representing a wide range of manufacturing and non-manufacturing companies. The report summarized key trends in ten diverse areas.

1. Drafting, Engineering Technology, Mechanical Design
2. Tool and Die, Machinist, NC
3. Electromechanical Technology
4. Industrial Engineering Technology
5. Metallurgy
6. Business Data Processing
7. Business Administration
8. Printing and Publishing
9. Health Occupations
10. Industrial Electronics

These were excellent summaries and represented a beginning for a series of Specific Skill Needs Assessments.

II. Human Resource Services Report for Machine Shop

The following key trends and comments are reported as they appeared in Future Skill Needs Assessment by Human Resource Services.

Summary of Key Trends

1. Required skills and knowledges for tool and die makers and machinists will include: computer skills - both programming and understanding of systems; ability to handle microprocessors; working knowledge of CNC and EDM equipment; ability to interpret computer generated data in a number of companies.

2. There appear to be present and growing needs for tool and die makers with knowledge of plastics and plastics molding skills.

3. High speed machining will require more academic preparation for tool and die makers in metallurgy and probably thermodynamics.

4. Their positioning in the CAD/CAM stream will require skilled machinists to have a much greater grasp of manufacturing processes and a concept of systems interface.

5. There will be continued, fairly rapid growth in the demand for people with NC programming skills. However, the tendency is clearly to build those skills into existing jobs which already interface with the machinery.

Machinist

- Programming and knowledge of microprocessors will be required of all our skilled machinists in five years - and sooner if we can get them;

- NC and CNC familiarity is a must for any new hiree;

- Must be able to do floor programming and edit programs;

- How much metric conversion is being taught down there? (MATC);

- All our skilled machinists will need to understand the marriage between the computer and machine tooling. That takes a lot more than "a black box" mentality about computer systems;

- Simply programming NC is not a big deal - we can teach that skill relatively quickly. What is critical, as we move into CAM, is some systems understanding;

- Skilled machinists must have up to date cutting tool technology knowledge - that requires short courses which have to be available somewhere in the educational system;

- If we were hiring apprentice machinists again (which we hope we will someday!), we have definite courses we would like to see them get on the academic side:

  1) NC - more than just an intro course; also needs CNC,
  2) a strong applied statistics course,
  3) a manufacturing process course that includes exposure to robotics, PCs, FMS, and MRP,
  4) a course in programming for micros.

  Those courses reflect skills and knowledges that we will require from any new skilled machinist we're hiring not more than three years in the future.

III. National Inventory of Machine Tools

In November of 1983, the American Machinist published the 13th Inventory of Metalworking Equipment. The inventory showed that the total number of numerically controlled machines installed in metalworking has nearly doubled since 1978. At the same time the total number of machine tools declined by 8%. During the same period the percentage of relatively modern metalworking machines increased from 31% to 34%. This was the first substantial increase since 1945. The following are national highlights of the 13th American Machinist's Inventory.

1. One-third of the plants that do turning work now have some NC turning machines, 58% of which were bought in the past five years.

2. Grinding machines are the most common machine tools, accounting for 17.5% of the total.

3. Cut off and sawing machines are found in most plants.

4. More than half of the NC machines are in plants making non-electrical machinery.

5. The smaller the plant is the newer its machine tools are likely to be.

6. The number of machine tools required to supply people with goods continues to decline, falling from 16 machine tools per thousand people in the country in 1968 to 9.8 in 1983.

The 13th American Machinist's Inventory divided the 48 contiguous states into 24 trading areas, each identified by the name of the major city in the area. The Milwaukee trading area contains approximately two-thirds of Wisconsin and is one of the geographically smaller areas of the twenty-four. Table 1 shows the inventory of machine tools in the Milwaukee trading area compared to continental U.S. total.

Some trends relating to the shift of metalworking out of the Northeast quadrant of the country were noted in the inventory, but the area that extends from New England across to Milwaukee and down to Philadelphia and St. Louis still has almost two-thirds of the nation's machine tools. This region had 72.8% of the machine tools in 1968 and it has 65.8% as of 1983. At the time of the survey there were 60,777 metalcutting machines, and 3,210 of these were NC machines.

Nationally, there were 16 machine tools per 1,000 population in 1968 and 9.8 machine tools per 1,000 population in 1983. This represents a decrease of 39%. For the Milwaukee area (most of Wisconsin) there were 25.1 machine tools per 1,000 population in 1968 and 13.7 machine tools per 1,000 in 1983. This represents a decrease of 45%. These decreases, both nationally and locally, are attributed to the following:

1. the greater productivity of the machine tools,

2. the simplification of design of many products so less machining is required,

3. increased reliance on imports.

This research concerned itself only with an accounting of past trends. It was concerned with conventional and NC machines. Our local questions are regarding future trends and projections of conventional (including automated) machine tools and computer-controlled machine tools.

IV. Machine Shop Instructors' Reaction

During the Fall 1983 Coordination/Organization meetings at MATC machine shop instructors addressed high technology in general and the Future Skills Needs Assessment in particular. A summary of the instructors' opinions was included in the minutes of that meeting. This summary stated:

> "Most present felt our Public Relations Department and top administration are listening to the large companies and the newspapers which of course, are all Hi-Tech. We also feel Hi-Tech is essential, but we feel that teaching the basic machine shop fundamental skills before entering into these Hi-Tech areas are also essential. It was also brought up that the majority of companies presently operating and advancing in the Hi-Tech areas are the large companies that have the money to back them. Accoridng to the slide presentation on August 18, 1983, in the Cooley Auditorium, 66% of area businesses are small companies.
>
> "It was then decided that a survey of our area machine shop businesses, large and small, would be needed to find out what they expect in terms of skills when students leave MATC and enter the labor force. It was suggested to personally take these surveys around because if they would be mailed out we could expect approximately only a 25% return."

V. Action Taken: Objectives

The Machine Shop and Tool and Die faculty met several times with staff from MATC's Research, Planning, and Development Office and the Placement Office to design a study that took advantage of the faculty enthusiasm and used it to establish partnerships with Milwaukee area industries while gathering concrete information for updating curriculum. The following objectives were used in designing the study:

1. To determine the nature of the machine tools currently used in industries of all sizes in southeastern Wisconsin.

2. To determine how many people are currently employed in these shops.

3. To determine the nature of the machine tools that will be used in these industries five years from now.

4. To determine how many people will be employed in the machine tool area five years from now.

5. To determine what skills should be taught to MATC students to prepare them to work in the Machine Shop of 1989.

VI. Research Design

With these objectives in mind a survey instrument was constructed and revised using the input of the Machine Shop and Tool and Die faculty. A list of manufacturers with machine shops was compiled using information supplied by the instructors, their professional organizations, and the Research, Planning, and Development office. Each faculty member then chose 15 machine shops to contact and interview. A packet of information including a description of the Machine Shop, Tool and Die, and NC programs along with the survey and a general description of MATC was prepared to be delivered with each interview. The interviewers were instructed to attach their business cards to this packet and leave it with the interviewee. A major strength of this study is that the interviewers were journeymen machinists and knowledgeable in the details of a machine shop. This gave the study credibility with the interviewees.

Each faculty member called the company to be interviewed, explained the study, and set up an appointment for a personal interview. The information packets were then either mailed in advance or hand delivered at the time of the interview, depending upon the interviewee's preference. All of the information presented in this report is the result of these face-to-face interviews.

As the interviewing process began, it became clear to the interviewers that different-sized shops had different needs. It was therefore decided to evaluate the data in four categories according to company size.

VII. Summary of Findings-Machine Shops That Employ Less Than 10 Machine Tool Operators

The machine shop faculty interviewed 41 shops that employed less than 10 people. The results of these interviews are displayed in Tables A1 through A6. Table A1 shows the number of each kind of machine in these small shops. There are a total of 433 machine tools (an average of 10.56 per shop). There are more milling machines than any other single category of machine tools. The total of NC, CNC, and DNC machine tools is 59 (this represents less than 14% of the machine tools in small shops). There are no Graphics Numerical Control machines in the small shops surveyed.

The data collected was used to estimate how many workers were on conventional machine tools and how many were on computer-controlled machine tools. These estimates show that approximately 236 were on conventional machines and 27 were on computer-controlled machines. (See Table A2.)

Each person interviewed was asked to estimate the percentage of conventional and the percentage of computer-controlled machine tools that would be in their shops in five years. They were also asked to estimate the number of employees they anticipate will be working as machine tool operators in their company in five years. This

information was used to make projections of the number of operations on computer-controlled machines. (See Table A3.) These estimates show that there will be approximately 338 operators on conventional machine tools and 125 on computer-controlled machine tools in five years. So, for the small shops it is estimated the number of machine tool operators on conventional machines will increase 43% and the number on computer-controlled machine tools will increase 363% in the next five years.

What does this mean in terms of new jobs? The number of current machine tool operators, the estimated number in five years, and the anticipated number of retirees were used to estimate the number of new positions opening in these small shops in the next five years. Table A4 shows that there will be approximately 236 new jobs available for machine tool operators in these 41 small shops over the next five years.

What kind of training do these small shops want their machine operators to have? The last four columns in Table A4 tabulate the small machine shop employer's expectations of new employees. Ninety-three percent (38 of 41) of those employers see tha machine tool operator of the future as being a multiple machine tool operator. The same percent (93%) feel that teaching the conventional machine tools (engine lathe, milling machine, turret lathe, and automatic screw machine) at MATC would provide the necessary training for new employers in their company.

Additional comments by employers from the small shops:

- There is a need for all around journeymen machinists in the tool & die industry.
- The proper operation of all machine tools relies on the performance of the cutting tool; therefore sharpening and shaping of tools to make them work is very important.
- Include punch press setup and maintenance.
- Less concern with programming and more on basic and safe practice!
- Would like to see some CNC training in the apprentice program.
- Absolute need for latest up-to-date equipment.
- We need people who really want to work and learn and take pride in doing it.
- There will be a drift away from machined products replaced by other technologies to make precision shaped parts. Need for basic skills still high.
- Anticipate expanding.

- Being a small shop we want to move to CNC equipment to reduce setup cost and number of operations, but we'll still need a complementary staff of conventional machine operators.

- Job shops will be a necessity to a surviving manufacturing economy. Small shops are more efficient because of hands-on control.

- The greatest asset of an employee is to have basic knowledge of inspection tools, blueprint reading, and concern for quality of finished parts.

- CAD/CAM will be used but we're not sure when or how.

- Individuals to have basic knowledge of computerized controlled equipment with some math, the ability to read, and understand drawing.

- Keep work area neat and clean.

- Get a better caliber of people to train.

- Taxes must go down.

- Taxes!

- I believe basics should be employed more at school than computers.

- A need for a good basic education in machine shop and its processes.

- The anticipated increase in employment will be people who have knowledge in the operation and setup of multiple spindle screw machines.

VIII. Summary of Findings-Machine Shops That Employ Between 10 and 49 Machine Tool Operators

The largest category in this study was the group of machine shops that employed between 10 and 49 machine tool operators. The machine shop faculty interviewed 64 of these shops. Tables B1 through B6 display the results of these interviews. The number and kind of machine tool in each shop are shown in Table B1. These moderate-sized shops have a total of 1,291 machine tools. This is an average of 20.17 per shop. Unlike the other shops, which have more milling machines, these shops have a majority of screw machines. Just as in the small shops, the moderate-sized shops have less than 14% computer-controlled machine tools.

The number of workers on conventional machine tools and on computer-controlled machine tools were estimated from the data collected. This showed that an estimated 1,063 operators were on conventional machines and 194 operators were on computer-controlled machines. (See Table B2.)

The moderate-sized shop employers supplied estimates of the percentages of conventional and computer-controlled machine tools that would be in their shops in five years. They also estimated the number of machine tool operators in their shop in five years. These estimates were used to make projections of the number of operators on conventional and computer-controlled machine tools five years from now. (See Table B3.) The estimates show that there will be approximately 1,099 operators on conventional machine tools and 550 on computer controlled machine tools.

This means that for the moderate-sized shops the number of machine operators on conventional machines will not increase over the next five years but the number on computer-controlled machines will increase 184% (from 194 to 550).

What does this mean in terms of new jobs? The information supplied by the employers was analyzed and displayed on Table B4 using the techniques described for Table A4. This projected that there would be approximately 850 new jobs for machine tool operators in these 64 moderate-sized shops over the next five years. A majority of these will probably be working on computer-controlled machines. It is probable that some of these CNC operators will evolve into these positions from the ranks of machine tool operators. This will open more entry-level machine operator positions than are indicated by the survey.

What kind of training does the moderate-sized shop want a new machine tool operator to have? The last four columns of Table B4 tabulate the moderate-sized machine shop employer's expectations of new employees. Seventy-nine percent (50 of 63) of these employers see tha machine tool operator of the future as being a multiple machine tool operator. This is a significant number but not as high as the 93% of the small shop employers that made the same recommendations. A slightly smaller percent (76%) feel that teaching the conventional machine tools at MATC would provide the necessary training for new employees.

Additional comments from employers at moderate-sized shops:

- -Training machine/tool operators should begin with good blueprint reading skills and knowledge of cutting tool geometry and grinding - conventional machine tools should be lerned first and NC machines after.
- - Basic maching background is a must, also emphasis on quality.
- - Speeds and feeds are very important. Basic machining is important.
- - Basic machine shop practices are necessary to the successful CNC, CAM, or FMS operator.

- The manufacturing engineer does all the programming. Basic machine tool skills and application are a must. Blueprint reading and basic drafting skills.

- Our employees must be able to handle all types of shop equipment.

- We feel that the students at MATC are given too much in too short a time. The smattering of knowledge they receive still leaves the employer burdened with completing the training. Machine shop could be of better use if an individual excelled on a bridgeport or an engine lathe.

- The teaching of the machining fundamentals is much more important than the small difference between conventional and advanced equipment.

- I believe the basics are a must in machine shop work.

- Need training for multiple screw machine operators.

- Automated screw machine basics.

- In five years we will not have enough people with the basic skills of machine trades.

- Use of math (trigonometry) is a prerequisite.

- There is a shortage of trained personnel.

- Theory of cutting tools, wire EDM.

- We need people with skills in communication, positive job attitude, and employer-employee relationship.

- Greater need for basic skill in computers, basic machine operations with emphasis on safety.

- Strongly stress "reading blueprints" and all basics.

- It would be a plus if the student had basic programming knowledge.

- Not necessary for all NC operators to be able to program.

- Stick to the basics.

- Should have general machine tool knowledge and mechanical ability and logic.

- NC is definitely the wave of the future, I believe machine cost is holding it back.

- Taxes!

- In the future big companies will be out and small companies will be in (because of unions).

- Get more into computers.

- Taxes are hurting us!

- I would not consider hiring anyone who has not training or experience on basic machine tools. Further more extensive training on screw machines would be a must.

- I would like to have a training source to teach multiple spindle courses.

- Computer-controlled machines will be used more in the future. Basic skills are still needed as a background.

- The program could benefit from teaching students multiple spindle machine operations as well as single spindle operations.

- Even though the trend is to computer aided machines it is our strong feeling that the basics must still be taught in order to operate machines. However, the courses should be set up where the individuals who have the basics can move right into the advanced courses.

IX. Summary of Findings-Machine Shops That Employ Between 50 and 99 Machine Tool Operators

The smallest category in the study was the group that employed between 50 and 99 machine tool operators. There were only 14 shops of this size interviewed. The results of these interviews are displayed in Tables C1 through C6. The number and kind of machine tool in each shop are shown in Table C1. There are a total of 468 machine tools (an average of 33.43 per shop). As with the smallest-sized shop and the largest-sized shop, there are more milling machines than any other category. Twenty-two percent of these machines are computer-controlled. This is a larger percentage than in the small shops but not as large a percentage as in the largest shops.

The number of workers on conventional machine tools and on computer-controlled machine tools were estimated from the data supplied by the employers. This information is shown on Table C2. There were an estimated 747 operators on conventional machines and 139 operators on computer-controlled machines.

Future estimates supplied by the employers were used to make projections of the number of operators on conventional and computer-controlled machine tools five years from now. These estimates are displayed in Table C3. They show that there will be approximately 638 operators on conventional and 308 operators on computer-controlled machine tools.

This means that the medium/large-sized shop will expect a decrease in the number of workers on conventional machine tools (from 747 to 638) and a corresponding increase in the number of workers on computer-controlled machine tools (from 139 to 308).

What does this mean in terms of new jobs? The survey information was analyzed and displayed on Table C4 using the techniques described for Table A4. It is projected that there will be approximately 195 new jobs in the 14 medium/large-sized shops over the next five years. It is likely that the majority of these new jobs will be on computer-controlled machine tools.

What kind of training does the medium/large-sized shop want a new machine tool operator to have? The last four columns of Table C4 tabulate the medium/large-sized machine shop employers' expectations of new employees. As with the other employers, they wanted a multiple machine tool operator and they felt that teaching the conventional mahine tools at MATC would provide the necessary training for their new employees.

Additional comments by employers at medium/large-sized shops:

- Definite need for a technical school that would teach the basics.
- Need more people who know the basics; e.g., more than machine "loaders."
- Stick to basics - also electronic trouble shooting is desirable.
- Even though there will be a reduction in machine operators, the number of retirees will create a need to hire more machine operators.
- We will have a programming department.
- People are getting highly technical and tolerance conscious.
- Although the trend is definitely toward complete NC controlled machines it is imperative that the people understand basic machine principles.
- Even though the majority of our machine tools will be CNC, I feel your school should only be teaching the fundamentals or basics of machine tool setup and operation. We will do our own training on our CNC machines.

X. Summary of Findings-Machine Shops That Employ More Than 100 Machine Tool Operators

Sixteen of the companies interviewed had more than 100 machine tool operators employed. The results of these sixteen interviews are shown in Tables D1 through D6. Table D1 shows the number and kind of

machine tool at each shop. There are a total of 1,153 machine tools at these large companies (an average of 72.06 per company). The majority of these are milling machines. Over twenty-seven percent of the machine tools in these large companies are computer-controlled. This is the largest percent of the four sample groups.

The number of workers on conventional and computer-controlled machine tools were estimated from the data provided by these large companies and are shown in Table D2. There were an estimated 2,893 operators on conventional and 492 operators on computer-controlled machines.

Estimates of future machines and employees supplied by the companies were used to make projections of the number of operators on conventional and computer-controlled machine tools five years from now. These estimates show that there will be approximately 2,470 operators on conventional and 1,242 operators on computer-controlled machine tools.

So, like the medium/large-sized shop, the large companies can expect a decline in the number of operators on conventional machine tools (from 2,893 to 2,470) and an increase in the number of workers on computer-controlled machine tools (from 492 to 1,242).

What does this mean in terms of new jobs? This survey information was analyzed and displayed on Table D4 using the techniques described for Table A4. This yielded a projection of 899 new jobs in the 16 large companies over the next five years. These jobs will most likely be on computer-controlled machine tools.

What kind of training does the large company want the new machine tool operator to have? The large companies' expectations of new employees are tabulated in the last four columns of Table D4. They, like the others, want a multiple machine tool operator. They feel that teaching the conventional machine tools at MATC would provide the necessary training for their new employees.

Additional comments by employers at large-sized companies:

- The trend will be toward setup reduction (through preset tooling, methods, improvement, etc.), operator inspection and control, and use of statistical process control.

- In the future machines will be programmed 100% using conversational on the floor rather than tape in the office.

- We are considered a light manufacturing industry and are moving toward less metal removal and automating the metal removal processes we now have. There will be less opportunities for machine tool operators because of this.

- When cutting metal, either mechanically, chemically, or electrically, many factors determine final outcome of the project, including machine design, the cutting tool and its geometry.

shape of the workpiece, tool material, work material, and the operator's capability. All factors are interrelated; the results depend on how knowledge, skills, and controls are collectively applied.

- Statistical quality control; true position tolerance.

- No more shaper training, please; add fundamentals on CNC machining.

- There will be a strong move toward CNC (CAM and CAD/CAM) with much less emphasis on conventional machines. The driving force is not just cost, but more importantly is: 1) higher quality of product, 2) reduced lead time, 3) reduced operator starting time.

- Additional blueprint reading - more time should be given on basic machines.

XI. Specific Skills Identified by Industry

All of the employers interviewed were asked to complete a Likert scale evaluation of importance of 21 curriculum topics. The analysis of these results are shown in Tables A5, B5, C5, and D5. The column at the left in each Table indicates whether or not an item should be included in the machine shop curriculum. If the mean rating of the Likert responses was 4.00 or greater, "yes" was placed in the column; if a mean rating of the Likert responses was 4.00 or greater, "consider" was placed in the column. The following topics were rated "yes" by all four groups (the Likert mean responses for each group is in parentheses):

Item 1: Perform basic arithmetic (4.63, 4.83, 4.86, 4.75).

Item 5: Read and interpret shop specifications (4.53, 4.77, 4.29, 4.94).

Item 6: Use measuring and inspection tools (4.90, 4.88, 4.64, 4.94).

Item 7: Read blueprints (4.88, 4.83, 4.79, 4.94).

Item 8: Perform the basic machine tool operations; drilling, reaming, tapping, etc. (4.71, 4.72, 4.57, 4.63).

The following categories were rated "yes" by three of the four groups:

Item 10: Knowledge of carbide cutting tools (4.38, 3.90, 4.05, 4.08).

Item 11: Determining feeds and speeds (4.00, 4.10, 4.24, 3.71).

The following topics were rated either "yes" (4.00+) or "consider" (3.00+) by all four groups:

Item 3: Perform geometry (3.20, 3.07, 3.55, 3.21).

Item 9: Knowledge of high-speed cutting tools (3.63, 3.75, 4.00, 3.77).

Item 12: Knowledge of tool grinding (3.31, 3.71, 3.73, 3.54).

Item 13: Operate NC machines (4.40, 3.00, 3.17, 3.71).

Item 15: Operate CNC machines (4.19, 3.11, 3.45, 3.75).

These results are consistent with the other sections of the survey which indicate an increased use of computer-controlled machine tools, especially in the larger shops, but consider an understanding of the basic machine tool operations as the foundation needed for the future.

XII. Advisory Committee Members

Any curriculum research project such as this establishes contacts in the community and helps build partnerships with business and industry. As a result of the MATC machine shop faculty contacting the Milwaukee area industries several interviewees indicated that they wuld be willing to serve on the machine shop advisory committee. The names, titles, and companies of these potential advisory committee members are listed in Tables A6, B6, C6, and D6. There were a total of 58 out of the 135 people surveyed who indicated they would serve on the advisory committee. That represents 43% of the people interviewed and indicates a real commitment from industry to be involved with MATC.

XIII. Skill Shortages Facing the Precision Metalworking Industry

Concurrent with the completion of our Specific Skill Needs Assessment was the publication of a survey of precision metalworking companies conducted by Louis Harris and Associates, Inc., sponsored by Sentry Insurance on behalf of the Task Force on the Skilled Trades Shortage. A summary of this report as it appeared in the March 1984 issue of Automatic Machining Magazine is included as Appendix 2.

XIV. Assumptions and Recommendations

The results of the Specific Skill Needs Assessment were presented to Machine Shop and Tool and Die faculty at a special coordination/ organization meeting on March 2, 1984. The results were discussed and the faculty were charged with analyzing the results and developing assumptions based upon the data presented and making recommendations for implementing a curriculum that is responsive to industry needs. The Machine Shop and Tool and Die faculty meet again on March 9, 1984, and unanimously approved the following assumptions and recommendations:

Assumptions	Recommendations
1. There is a need for basic machining skills in the Milwaukee area machine shops.	1. Basic machine tool skills shall remain in the Machine Shop and Tool and Die curriculum.
2. Milwaukee area employers see the machine tool operator of the future as being a multiple machine tool operator.	2. a) Provide a machine tool operator curriculum that would allow the student to learn the operation of multiple machine tools. b) Provide the counseling that would encourage the student to learn the operation of multiple machine tools.
3. There is a need for multi-spindle screw machine operators in the Milwaukee area (30% of the machine tools in the survey were screw machines).	3. Provide multiple spindle screw machine courses. (This will require additional equipment.)
4. There is a need for milling machine operators in the Milwaukee area (36% of the machine tools in the survey).	4. Provide more milling machine instruction. (This will require additional equipment.)
5. There will be an increasing need for CNC machine tool operators in the future with a background in basic machine tool operation or tool and die making.	5. Provide CNC Machine Tool courses in the Machine Shop and Tool and Die curriculum.
6. Basic reading and arithmetic skills are needed by machine tool operators.	6. a) Pretesting in mathematics, reading, spatial visualization, and mechanical aptitude should be instituted for all incoming students, and entry-level standards should be recommended based upon the data available. b) A basic skills pre-machine shop program should be available for students who do not meet the entry requirements.

NOTE: The Machine Shop and Tool and Die faculty met again on March 28, 1984. The minutes of that meeting are in Appendix 4.

TABLE 1

Comparison of Milwaukee Area Machine Tool Inventory to the Total U.S.

	Milwaukee Area (Most of Wisconsin)	U.S. Total
% of Plants with Metalcutting Machines	93%	92%
Total Machines	60,777	1,702,833
Age (%)		
0-4	12%	14%
5-9	19%	20%
10-19	34%	34%
20 & up	35%	32%
% of Plants with Metalforming Machines	76%	74%
Total Machines	15,879	489,921
Age (%)		
0-4	8%	9%
5-9	18%	18%
10-19	36%	36%
20 & up	38%	37%
% of Plants with NC		
Turning	26%	26%
Machining Centers	21%	19%
Punching	9%	8%

Source: 13th American Machinist Inventory.

TABLE A-1

MACHINE TOOLS CURRENTLY IN USE (Shops Employing Less Than 10)

Abbreviation	Lathe	Mill	Turret	Screw	NC	GNC	CNC	DNC
AbbotMach	3	3	7	0	0	0	1	0
Adelmeyer	2	9	0	0	0	0	3	0
AlboCorp	3	8	2	6	1	0	0	0
ApolloMach	1	1	8	0	0	0	0	0
BannerTool	4	12	0	0	3	0	2	0
Bostrom	4	4	0	0	0	0	0	0
Chilton	1	1	0	0	0	0	0	0
CustomInc	1	1	0	0	0	0	0	0
DingsCo	2	1	2	0	1	0	1	0
E-ZPainter	2	3	0	0	2	0	0	0
Elec-Mech	1	6	5	1	0	0	0	0
FoxPt.Mfg	3	8	1	0	0	0	3	0
G-PManufac	3	4	1	0	1	0	0	0
GenMachCo	1	1	1	0	0	0	0	0
GenScrew	1	4	3	11	0	0	1	0
Germantown	2	1	0	0	0	0	0	0
HeilComp	3	2	6	0	3	0	6	0
Kay-Bee	0	3	2	8	0	0	0	0
KnuthMach	3	6	0	0	0	0	5	0
L-WMachine	2	3	4	9	0	0	0	0
MachineCraf	1	3	2	1	0	0	0	0
MagnumProd	0	1	1	12	0	0	0	0
Milwest	2	5	7	0	0	0	3	2
MWM-Murphy	1	7	4	1	1	0	0	0
NatMachSpe	1	4	2	0	2	0	1	0
Numetech	0	1	0	0	3	0	1	0
O'Donn-Corr	1	0	1	12	0	0	0	0
P&WMachine	1	3	3	0	0	0	1	0
PawlakTool	2	6	1	0	0	0	0	0
PemperEng	1	1	1	0	1	0	0	0
Perfect	2	3	1	10	0	0	0	0
PerowTool	6	4	2	1	0	0	0	0
QMC,Inc	2	4	1	1	0	0	0	0
Reliable	0	0	3	0	0	0	0	0
RoseCo	2	1	3	0	1	0	1	0
SuperProd	0	0	1	0	0	0	0	0
TapeMach	0	0	0	0	4	0	3	0
VassilMach	2	4	3	3	0	0	0	0
W.AllisCo	1	2	2	0	0	0	0	0
WESCO	4	2	2	1	0	0	2	0

Table A-1(Continued)

MACHINE TOOLS CURRENTLY IN USE (Shops Employing Less Than 10)

Abbreviation	Lathe	Mill	Turret	Screw	NC	GNC	CNC	DNC
WIMachShop	5	7	0	0	0	0	0	0
Total:	76	139	82	77	23	0	34	2

Note: The column headings are identified as follows:

Lathe = engine lathe
Mill = milling machine
Turret = turret lathe
Screw = automatic screw machine
NC = point-to-point numerical control machine
GNC = graphics numerical control machine
CNC = computer numerical control machine
DNC = distributive numerical control machine

TABLE A-2

ESTIMATES OF MACHINISTS WORKING WITH NC (Shops Employing Less Than 10)

Abbreviation	Conv %	Comp %	Wkrs	Machinists	NC Machinists
AbbotMach	94	6	5	4.70	0.30
Adelmeyer	75	25	1	0.75	0.25
AlboCorp	100	0	6	6.00	0.00
ApolloMach	100	0	3	3.00	0.00
BannerTool	90	10	6	5.40	0.60
Bostrom	99	1	8	7.92	0.08
Chilton	100	0	3	3.00	0.00
CustomInc	100	0	1	1.00	0.00
DingsCo	75	25	8	6.00	2.00
E-ZPainter	95	5	5	4.75	0.25
Elec-Mech	100	0	8	8.00	0.00
FoxPt.Mfg	85	15	4	3.40	0.60
G-PManufac	90	10	3	2.70	0.30
GenMachCo	100	0	3	3.00	0.00
GenScrew	95	5	7	6.65	0.35
Germantown	100	0	1	1.00	0.00
HeilComp	90	10	43	38.70	4.30
Kay-Bee	100	0	6	6.00	0.00
KnuthMach	70	30	7	4.90	2.10
L-WMachine	100	0	6	6.00	0.00
MachineCraf	85	15	3	2.55	0.45
MagnumProd	100	0	8	8.00	0.00
Milwest	70	30	7	4.90	2.10
MWM-Murphy	95	5	6	5.70	0.30
NatMachSpe	97	3	9	8.73	0.27
Numetech	10	90	5	0.50	4.50
O'Donn-Corr	100	0	5	5.00	0.00
P&WMachine	99	1	7	6.93	0.07
PawlakTool	100	0	4	4.00	0.00
PemperEng	90	10	8	7.20	0.80
Perfect	100	0	8	8.00	0.00
PerowTool	100	0	8	8.00	0.00
QMC,Inc	100	0	7	7.00	0.00
Reliable	100	0	6	6.00	0.00
RoseCo	95	5	10	9.50	0.50
SuperProd	100	0	1	1.00	0.00
TapeMach	15	85	6	0.90	5.10
VassilMach	100	0	8	8.00	0.00
W.AllisCo	100	0	3	3.00	0.00
WESCO	80	20	9	7.20	1.80
WIMachShop	10	0	9	270.90	0.00

TABLE A-2 (Continued)

ESTIMATES OF MACHINISTS WORKING WITH NC (Shops Employing Less Than 10)

Abbreviation	Conv %	Comp %	Wkrs	Machinists	NC Machinists
Total:	3,604	406	271	235.88	27.02

Note: The column headings are identified as follows:

Conv % = The percent of conventional machine tools in each shop.
Comp % = The percent of computer controlled machine tools in each shop.
Wkrs = The number of workers in each shop.
Machinists = An estimate of the number of workers working on conventional machine tools (Conv % x Wkrs).
NC Machinists = An estimate of the number of workers on computer controlled machine tools (Comp % x Wkrs).

TABLE A-3

MACHINISTS WORKING WITH NC IN 5 YEARS (Shops Employing Less Than 10)

Abbreviation	Conv5 %	Comp5 %	Wkrs 5	Machinists	NC Machinists
AbbotMach	70	30	20	14.00	6.00
Adelmeyer	60	40	1	0.60	0.40
AlboCorp	100	0	12	12.00	0.00
ApolloMach	85	15	10	8.50	1.50
BannerTool	80	20	7	5.60	1.40
Bostrom	95	5	15	14.25	0.75
Chilton	100	0	5	5.00	0.00
CustomInc	100	0	1	1.00	0.00
DingsCo	5	95	12	0.60	11.40
E-ZPainter	80	20	9	7.20	1.80
Elec-Mech	90	10	13	11.70	1.30
FoxPt.Mfg	60	40	7	4.20	2.80
G-PManufac					
GenMachCo	75	25	4	3.00	1.00
GenScrew	85	15	20	17.00	3.00
Germantown	100	0	2	2.00	0.00
HeilComp	80	20	43	34.40	8.60
Kay-Bee	100	0	8	8.00	0.00
KnuthMach	70	30	11	7.70	3.30
L-WMachine	85	15	12	10.20	1.80
MachineCraf	0	100	10	0.00	10.00
MagnumProd	85	15	16	13.60	2.40
Milwest	50	50	14	7.00	7.00
MWM-Murphy	80	20	10	8.00	2.00
NatMachSpe	50	50	30	15.00	15.00
Numetech	10	90	10	1.00	9.00
O'Donn-Corr	100	0	10	10.00	0.00
P&WMachine			7		
PawlakTool	90	10	6	5.40	0.60
PemperEng	75	25	23	17.25	5.75
Perfect	100	0	8	8.00	0.00
PerowTool			15		
QMC,Inc	65	35	21	13.65	7.35
Reliable	100	0	6	6.00	0.00
RoseCo	95	5	25	23.75	1.25
SuperProd	100	0	3	3.00	0.00
TapeMach	0	100	10	0.00	10.00
VassilMach	90	10	20	18.00	2.00
W.AllisCo	100	0	3	3.00	0.00
WESCO	40	60	12	4.80	7.20

TABLE A-3 (Continued)

MACHINISTS WORKING WITH NC IN 5 YEARS (Shops Employing Less Than 10)

Abbreviation	Conv5 %	Comp5 %	Wkrs 5	Machinists	NC Machinists
WIMachShop	100	0	14	14.00	0.00
Total:	2,850	950	485	338.40	124.60

Note: The column headings are identified as follows:

Conv5 % = The percent of conventional machine tools that will probably be in each shop in 5 years.

Comp5 % = The percent of computer controlled machine tools that will probably be in each shop in 5 years.

Wkrs 5 = The employer's estimate of the number of workers in each shop in 5 years.

Machinists = An estimate of the number of workers that will be working on conventional machine tools in 5 years (Conv5% x Wkrs).

NC Machinists = An estimate of the number of workers that will be working on computer controlled machine tools in 5 years (Comp5 % x Wkrs).

TABLE A-4

NEW JOBS IN MACHINE SHOPS (Shops Employing Less Than 10)

Abbreviation	Wkrs	Wkrs 5	Retire	New	Special	Mltpl	Trg Y	Trg N
AbbotMach	5	20	0	15.00	0	1	1	0
Adelmeyer	1	1	0	0.00	0	1	0	1
AiboCorp	6	12	0	6.00	0	1	1	0
ApolloMach	3	10	0	7.00	0	1	1	0
BannerTool	6	7	1	2.00	0	1	1	0
Bostrom	8	15	0	7.00	0	1	1	0
Chilton	3	5	2	4.00	0	1	1	0
CustomInc	1	1	0	0.00	0	1	1	0
DingsCo	8	12	0	4.00	0	1	1	0
E-ZPainter	5	9	1	5.00	0	1	1	0
Elec-Mech	8	13	0	5.00	0	1	1	0
FoxPt.Mfg	4	7	0	3.00	0	1	1	0
G-PManufac	3		0	-3.00	0	1	1	0
GenMachCo	3	4	0	1.00	0	1	1	0
GenScrew	7	20	0	13.00	0	1	1	0
Germantown	1	2	0	1.00	0	1	1	0
HeilComp	43	43	5	5.00	0	1	1	0
Kay-Bee	6	8	0	2.00	0	1	1	0
KnuthMach	7	11	0	4.00	0	1	1	0
L-WMachine	6	12	1	7.00	0	1	1	0
MachineCraf	3	10	0	7.00	1	0	1	0
MagnumProd	8	16	0	8.00	0	1	1	0
Milwest	7	14	0	7.00	0	1	1	0
MWM-Murphy	6	10	2	6.00	0	1	1	0
NatMachSpe	9	30	2	23.00	0	1	1	0
Numetech	5	10	0	5.00	0	1	1	0
O'Donn-Corr	5	10	0	5.00	0	1	1	0
P&WMachine	7	7	0	0.00	1	0	1	0
PawlakTool	4	6	1	3.00	0	1	0	1
PemperEng	8	23	0	15.00	0	1	1	0
Perfect	8	8	1	1.00	0	1	1	0
PerowTool	8	15	0	7.00	0	1	1	0
QMC,Inc	7	21	1	15.00	0	1	1	0
Reliable	6	6	0	0.00	0	1	1	0
RoseCo	10	25	2	17.00	0	1	1	0
SuperProd	1	3	0	2.00	0	1	1	0
TapeMach	6	10	0	4.00	0	1	0	1
VassilMach	8	20	0	12.00	0	1	1	0
W.AllisCo	3	3	1	1.00	0	1	1	0
WESCO	**9**	**12**	**0**	**3.00**	**1**	**0**	**1**	**0**

TABLE A-4 (Continued)

NEW JOBS IN MACHINE SHOPS (Shops Employing Less Than 10)

Abbreviation	Wkrs	Wkrs 5	Retire	New	Special	Mltpl	Trg Y	Trg N
WIMachShop	9	14	2	7.00	0	1	1	0
Total:	271	485	22	236.00	3	38	38	3

Note: The column headings are identified as follows:

Wkrs = The number of workers in each shop.
Wkrs 5 = The employer's estimate of the number of workers in each shop in 5 years.
Retire = The employer's estimate of the number of machine tool operators that will be retiring in the next 5 years.
New = The number of new jobs for machine tool operators (Wkrs 5 - Wkrs - Retire).
Special = The employer sees the future direction of machine tool operators as specializing on one machine tool.
Mltpl = The employer sees the future direction of machine tool operators as being a multiple machine tool operator.
Trg Y = The employer feels that teaching the conventional machine tools would provide the necessary training for new employees.
Trg N = The employer feels that teaching the conventional machine tools would not provide the necessary training for new employees.

THESE PROJECTIONS ARE CONSERVATIVE In every case where the employer did not make a projection for future employment (Column Wkrs 5) the most conservative assumption 0 was used.

TABLE A-5

SPECIFIC SKILL NEEDS ASSESSMENT FOR MACHINE SHOPS IN SOUTHEASTERN WISCONSIN
(Shops Employing Less than 10)

	ITEM	5	4	3	2	1	MEAN	NUMBER
YES	1. PERFORM ARITHMETIC	30	9	1	0	1	4.63	41
CONSIDER	2. PERFORM ALGEBRA	9	7	8	7	8	3.05	39
CONSIDER	3. PERFORM GEOMETRY	5	6	8	4	5	3.07	28
CONSIDER	4. PERFORM TRIGONOMETRY	14	6	10	4	4	3.58	38
YES	5. READ & INTERPRET SHOP SPECIFICATIONS	28	8	2	1	1	4.53	40
YES	6. USE MEASURING & INSPECT TOOLS	37	4	0	0	0	4.90	41
YES	7. READ BLUEPRINTS	35	5	0	0	0	4.88	40
YES	8. PERFORM BASIC MACHINE TOOL OPERATIONS	33	4	4	0	0	4.71	41
CONSIDER	9. KNOWLEDGE OF HIGH SPEED CUTTING TOOLS	14	8	13	4	1	3.75	40
CONSIDER	10. KNOWLEDGE OF CARBIDE CUTTING TOOLS	14	11	12	0	2	3.90	39
YES	11. FEEDS & SPEEDS	18	12	8	3	0	4.10	41
CONSIDER	12. TOOL GRINDING	17	6	10	5	3	3.71	41
CONSIDER	13. OPERATE NC MACHINES	9	4	5	0	11	3.00	29
	14. PROGRAM NC MACHINES	4	2	7	3	11	2.44	27
CONSIDER	15. OPERATE CNC MACHINES	9	2	7	1	8	3.11	27
	16. PROGRAM CNC MACHINES	7	4	2	3	11	2.74	27
	17. OPERATE GNC MACHINES	3	0	4	2	10	2.16	19
	18. PROGRAM GNC MACHINES	4	0	3	1	11	2.21	19
	19. OPERATE DNC MACHINES	0	1	4	1	11	1.71	17
	20. PROGRAM DNC MACHINES	2	0	2	1	12	1.76	17
	21. PROGRAM CAM SYSTEMS	4	0	3	0	12	2.16	19

TABLE A-6

ADVISORY COMMITTEE POTENTIAL (Shops Employing Less Than 10)

Interviewee	Title	Firm Name
Al Krzewina	President	Milwest Machine
Daniel Schnabel	Superintendent	Banner Tool & Eng. Corp.
Don Juds	Works Manager	Abbot Machine Company
Joe Santi	President	QMC, Inc.
John Angster	Personnel Manager	Bostrom
Kenneth Wesley	President	L-W Machine Products, Inc.
Leonard Mueller	Vice President	WESCO Machine Products
Mervin Leske	Vice President, Mfg.	E-Z Painter
Michael F. Liburdi	General Mananger	Fox Point Tool & Mfg.
Richard Jackson	President	Perfect Screw Products
Roger E. Carstedt	President	Numetech, Inc.
William E. Zastrow	President	Magnum Screw Products Corp.
William Schmeling	Plant Manager	Chilton Union

TABLE B-1

MACHINE TOOLS CURRENTLY IN USE (Shops Employing 10-49)

Abbreviation	Lathe	Mill	Turret	Screw	NC	GNC	CNC	DNC
A-PlusMach	1	4	0	22	0	0	0	0
AAASales	1	5	2	0	0	0	13	0
Accurate	1	2	3	28	0	0	0	0
AdvScrewPro		12	10	13	0	0	0	0
AmerCanCo	6	4	0	0	3	0	0	0
Aqua-Chem	2	3	3	0	3	0	3	0
ArrowInd	0	1	1	0	1	0	1	0
ArtosEngCo	5	14	0	0	7	0	10	0
BartonProd	3	9	3	43	0	0	2	0
Bolens	0	7	3	4	6	0	2	0
Bradley	2	2	4	6	0	0	1	0
CraneMfg	3	2	2	0	0	0	2	0
Delco	8	13	0	0	0	0	2	0
Deltrol	0	2	0	0	0	0	0	0
Denco	2	3	3	0	0	0	2	0
Ditt-FreCor	8	11	3	3	4	0	2	0
Dynamic	2	2	0	0	0	0	3	0
EntrustCo	2	10	0	0	1	0	0	1
ErieMfgCo	4	4	3	6	2	0	0	0
EST	0	7	2	0	0	0	0	0
Frantz	3	6	3	10	0	0	0	0
FusionCo	1	8	1	0	2	0	3	0
Galland	5	2	4	5	0	0	0	0
GrobInc	8	4	3	2	3	0	0	0
H&K,Inc.	4	5	0	0	0	0	3	0
HanelCorp	20	8	0	4	0	0	7	0
Harman	3	6	6	12	0	0	0	0
Herd&KlugCor	8	10	1	0	4	0	0	0
HerkerInc	1	6	4	30	0	0	2	0
Inter T&E	3	11	0	0	0	0	4	0
Kempsmith	4	5	4	0	1	0	2	0
Koehring	2	3	2	0	1	0	5	0
Krueger	1	6	3	0	1	0	1	0
Lakeside	2	2	1	0	0	0	3	0
Logeman	3	4	2	0	1	0	3	0
MantelMach	1	10	3	33	0	0	0	0
MarkerMach	2	5	0	0	0	0	5	0
MasterMach	1	2	1	20	2	0	0	0
MechIndus	6	10	5	12	0	0	2	0
MilFaucets	0	1	2	15	0	0	0	0

TABLE B-1 (Continued)

MACHINE TOOLS CURRENTLY IN USE (Shops Employing 10-49)

Abbreviation	Lathe	Mill	Turret	Screw	NC	GNC	CNC	DNC
MilMach	2	5	10	48	0	0	0	0
MilParts	7	4	4	0	2	0	0	0
MilPress	10	13	1	0	4	0	2	0
ModEquipCo	6	4	1	0	1	0	2	0
NatlScrew	1	4	6	11	2	0	2	0
Perlick	4	6	10	3	0	0	1	0
POW Mach	2	3	1	3	2	1	2	0
PreScrewThd	2	4	1	0	0	0	3	0
Riverside	7	6	6	0	1	0	0	0
SchmidtEng	3	2	1	0	0	0	0	0
ScrewMach	6	4	2	22	0	0	0	0
SingerT&D	4	8	0	0	0	0	0	0
SnapOnTool	0	4	0	20	0	0	0	0
SquareD	1	3	1	2	0	0	6	0
StanekTool	7	14	0	0	1	2	2	0
Starline	3	12	5	14	0	0	0	0
SuperSteel	0	1	0	0	6	0	0	0
Sure-Way	4	8	0	0	0	0	1	0
SurinakMch	3	5	8	1	0	0	1	0
UllmanInc	2	2	0	9	1	0	3	0
WallerMach	1	1	4	0	0	0	0	0
WesleyT&D	1	6	0	0	0	0	0	0
Williams	0	1	1	1	0	0	0	0
Zierden	3	3	4	0	0	0	1	0
Total:	207	354	153	402	62	3	109	1

Note: See Table A-1 for description of column headings.

TABLE B-2

ESTIMATES OF MACHINISTS WORKING WITH NC (Shops Employing 10-49)

Abbreviation	Conv %	Comp %	Wkrs	Machinists	NC Machinists
A-PlusMach	100	0	12	12.00	0.00
AAASales	25	75	49	12.25	36.75
Accurate	100	0	16	16.00	0.00
AdvScrewPro	100	0	35	35.00	0.00
AmerCanCo	98	2	28	27.44	0.56
Aqua-Chem	70	30	26	18.20	7.80
ArrowInd	90	10	20	18.00	2.00
ArtosEngCo	25	75	34	8.50	25.50
BartonProd	95	5	45	42.75	2.25
Bolens	80	20	20	16.00	4.00
Bradley	95	5	30	28.50	1.50
CraneMfg	80	20	12	9.60	2.40
Delco	96	4	24	23.04	0.96
Deltrol	100	0	12	12.00	0.00
Denco	80	20	12	9.60	2.40
Ditt-FreCor	86	14	20	17.20	2.80
Dynamic	60	40	15	9.00	6.00
EntrustCo	60	40	16	9.60	6.40
ErieMfgCo	90	10	15	13.50	1.50
EST	97	3	15	14.55	0.45
Frantz	100	0	18	18.00	0.00
FusionCo	80	20	10	8.00	2.00
Galland	100	0	36	36.00	0.00
GrobInc	95	5	30	28.50	1.50
H&K,Inc.	85	15	32	27.20	4.80
HanelCorp	60	40	17	10.20	6.80
Harman	100	0	10	10.00	0.00
Herd&KlugCor	75	25	25	18.75	6.25
HerkerInc	90	10	40	36.00	4.00
Inter T&E	75	25	20	15.00	5.00
Kempsmith	95	5	19	18.05	0.95
Koehring	50	50	13	6.50	6.50
Krueger	95	5	12	11.40	0.60
Lakeside	67	33	10	6.70	3.30
Logeman	80	20	10	8.00	2.00
MantelMach	100	0	30	30.00	0.00
MarkerMach	50	50	12	6.00	6.00
MasterMach	100	0	18	18.00	0.00
MechIndus	98	2	30	29.40	0.60
MilFaucets	100	0	20	20.00	0.00

TABLE B-2 (Continued)

ESTIMATES OF MACHINISTS WORKING WITH NC (Shops Employing 10-49)

Abbreviation	Conv %	Comp %	Wkrs	Machinists	NC Machinists
MilMach	100	0	39	39.00	0.00
MilParts	100	0	15	15.00	0.00
MilPress	80	20	20	16.00	4.00
ModEquipCo	99	1	10	9.90	0.10
NatlScrew	90	10	22	19.80	2.20
Perlick	98	2	21	20.58	0.42
POW Mach	60	40	10	6.00	4.00
PreScrewThd	85	15	25	21.25	3.75
Riverside	75	25	18	13.50	4.50
SchmidtEng	100	0	10	10.00	0.00
ScrewMach	100	0	18	18.00	0.00
SingerT&D	95	5	13	12.35	0.65
SnapOnTool	100	0	48	48.00	0.00
SquareD	50	50	10	5.00	5.00
StanekTool	8	15	40	3.20	6.00
Starline	90	10	12	10.80	1.20
SuperSteel	100	0	4	4.00	0.00
Sure-Way	90	10	10	9.00	1.00
SurinakMch	90	10	12	10.80	1.20
UllmanInc	75	25	25	18.75	6.25
WallerMach	100	0	5	5.00	0.00
WesleyT&D	100	0	20	20.00	0.00
Williams	100	0	1	1.00	0.00
Zierden	95	5	12	11.40	0.60
Total:	5,402	921	1,288	1,062.76	194.44

Note: See Table A-2 for description of column headings.

TABLE B-3

MACHINISTS WORKING WITH NC IN 5 YEARS (Shops Employing 10-49)

Abbreviation	Conv5 %	Comp5 %	Wkrs 5	Machinists	NC Machinists
A-PlusMach	100	0	12	12.00	0.00
AAASales	10	90	75	7.50	67.50
Accurate	70	30	19	13.30	5.70
AdvScrewPro	100	0			
AmerCanCo	95	5	30	28.50	1.50
Aqua-Chem	50	50	50	25.00	25.00
ArrowInd	50	50	40	20.00	20.00
ArtosEngCo	20	80	66	13.20	52.80
BartonProd	80	20	75	60.00	15.00
Bolens	75	25	40	30.00	10.00
Bradley	75	25	45	33.75	11.25
CraneMfg	65	35	18	11.70	6.30
Delco	85	15	20	17.00	3.00
Deltrol	100	0	12	12.00	0.00
Denco	60	40	36	21.60	14.40
Ditt-FreCor	67	33	25	16.75	8.25
Dynamic	70	30	20	14.00	6.00
EntrustCo	20	80	30	6.00	24.00
ErieMfgCo	75	25	20	15.00	5.00
EST	80	20	20	16.00	4.00
Frantz	80	20	20	16.00	4.00
FusionCo	75	25	15	11.25	3.75
Galland	90	10	28	25.20	2.80
GrobInc	95	5	30	28.50	1.50
H&K,Inc.	50	50	40	20.00	20.00
HanelCorp	50	50	35	17.50	17.50
Harman	90	10	25	22.50	2.50
Herd&KlugCor	70	30	30	21.00	9.00
HerkerInc	75	25	45	33.75	11.25
Inter T&E	50	50	20	10.00	10.00
Kempsmith	50	50			
Koehring	75	25	8	6.00	2.00
Krueger	95	5	15	14.25	0.75
Lakeside	33	67	20	6.60	13.40
Logeman	70	30			
MantelMach	90	10	50	45.00	5.00
MarkerMach	40	60	18	7.20	10.80
MasterMach	100	0			
MechIndus	85	15	15	12.75	2.25
MilFaucets	100	0	24	24.00	0.00

TABLE B-3 (Continued)

MACHINISTS WORKING WITH NC IN 5 YEARS (Shops Employing 10-49)

Abbreviation	Conv5 %	Comp5 %	Wkrs 5	Machinists	NC Machinists
MilMach	100	0	39	39.00	0.00
MilParts	100	0	20	20.00	0.00
MilPress	60	40	50	30.00	20.00
ModEquipCo	95	5	30	28.50	1.50
NatlScrew	65	35	35	22.75	12.25
Perlick	96	4	27	25.92	1.08
POW Mach	20	80	15	3.00	12.00
PreScrewThd	75	25	35	26.25	8.75
Riverside	60	40	18	10.80	7.20
SchmidtEng	80	20	20	16.00	4.00
ScrewMach	100	0	24	24.00	0.00
SingerT&D	90	10	0	0.00	0.00
SnapOnTool			400		
SquareD	50	50	15	7.50	7.50
StanekTool	70	30	60	42.00	18.00
Starline	70	30	12	8.40	3.60
SuperSteel	25	75	30	7.50	22.50
Sure-Way	90	10	15	13.50	1.50
SurinakMch	75	25	25	18.75	6.25
UllmanInc	70	30	38	26.60	11.40
WallerMach	100	0	5	5.00	0.00
WesleyT&D	80	20	20	16.00	4.00
Williams			4		
Zierden	50	50	25	12.50	12.50
Total:	4,431	1,769	2,053	1,098.77	550.23

Note: See Table A-3 for description for column headings.

TABLE B-4

NEW JOBS IN MACHINE SHOPS (Shops Employing 10-49)

Abbreviation	Wkrs	Wkrs 5	Retire	New	Special	Mltpl	Trg Y	Trg N
A-PlusMach	12	12	0	0.00	1	0	1	0
AAASales	49	75	0	26.00	0	1	1	0
Accurate	16	19	0	3.00	0	1	1	0
AdvScrewPro	35		0	-35.00				0
AmerCanCo	28	30	5	7.00	0	1	1	0
Aqua-Chem	26	50	14	38.00	0	1	0	1
ArrowInd	20	40	1	21.00	0	1	1	0
ArtosEngCo	34	66	2	34.00	0	1	1	0
BartonProd	45	75	1	31.00	0	1	1	0
Bolens	20	40	5	25.00	0	1	1	0
Bradley	30	45	0	15.00	0	1	1	0
CraneMfg	12	18	2	8.00	0	1	0	1
Delco	24	20	7	3.00	0	1	0	1
Deltrol	12	12	1	1.00	0	1	1	0
Denco	12	36	0	24.00	1	1	1	0
Ditt-FreCor	20	25	1	6.00	0	1	0	1
Dynamic	15	20	0	5.00	0	1	0	1
EntrustCo	16	30	0	14.00	1	1	0	1
ErieMfgCo	15	20	0	5.00	0	1	1	0
EST	15	20	2	7.00	0	1	1	0
Frantz	18	20	0	2.00	0	1	1	0
FusionCo	10	15	0	5.00	0	1	1	0
Galland	36	28	2	-6.00	0	1	1	0
GrobInc	30	30		0.00	1	0	1	0
H&K,Inc.	32	40	0	8.00	0	1	1	0
HanelCorp	17	35	0	18.00	1	0	0	1
Harman	10	25	0	15.00	0	1	1	0
Herd&KlugCor	25	30	0	5.00		0		0
HerkerInc	40	45	1	6.00	0	1	0	1
Inter T&E	20	20	0	0.00	0	1	1	0
Kempsmith	19		4	-15.00	0	1	1	0
Koehring	13	8	1	-4.00	0	1	1	0
Krueger	12	15	0	3.00	0	1	1	0
Lakeside	10	20	2	12.00	0	1	1	0
Logeman	10		0	-10.00	0	1	1	0
MantelMach	30	50	0	20.00	0	1	1	0
MarkerMach	12	18	0	6.00	0	1	1	0
MasterMach	18		1	-17.00			1	0
MechIndus	30	15	0	-15.00		1	1	0
MilFaucets	20	24	1	5.00	1	0	1	0

TABLE B-4 (Continued)

NEW JOBS IN MACHINE SHOPS (Shops Employing 10-49)

Abbreviation	Wkrs	Wkrs 5	Retire	New	Special	Mltpl	Trg Y	Trg N
MilMach	39	39	7	7.00	0	1	0	1
MilParts	15	20	1	6.00	0	1	1	0
MilPress	20	50	3	33.00	1	0	1	0
ModEquipCo	10	30	1	21.00	0	1	0	1
NatlScrew	22	35	4	17.00	0	1	1	0
Perlick	21	27	3	9.00	1	0	1	0
POW Mach	10	15	0	5.00	0	1	1	0
PreScrewThd	25	35	0	10.00	0	1	1	0
Riverside	18	18	0	0.00	0	1	1	0
SchmidtEng	10	20	0	10.00	1	0	1	0
ScrewMach	18	24	0	6.00	0	1	1	0
SingerT&D	13	0	0	-13.00	0	1	1	0
SnapOnTool	48	400	0	352.00	0	1	1	0
SquareD	10	15		5.00	1	0	0	1
StanekTool	40	60	5	25.00	1	0	0	1
Starline	12	12	0	0.00	0	1	1	0
SuperSteel	4	30	2	28.00	0	1	0	1
Sure-Way	10	15	2	7.00	0	1	1	0
SurinakMch	12	25	0	13.00	1	0	1	0
UllmanInc	25	38	3	16.00	0	1	1	0
WallerMach	5	5	0	0.00	0	1	0	1
WesleyT&D	20	20	2	2.00	0	1	1	0
Williams	1	4	0	3.00	1	0	0	1
Zierden	12	25	0	13.00	0	1	1	0
Total:	1,288	2,053	86	851.00	13	50	47	15

Note: See Table A-4 for description of column headings.
THESE PROJECTIONS ARE CONSERVATIVE In every case where the employer did not make a projection for future employment (Cclumn Wkrs 5) the most conservative assumption of 0 was used.

TABLE B-5

SPECIFIC SKILL NEEDS ASSESSMENT FOR MACHINE SHOPS IN SOUTHEASTERN WISCONSIN
(Shops Employing 10-49)

	ITEM	5	4	3	2	1	MEAN	NUMBER
YES	1. PERFORM ARITHMETIC	57	4	2	1	0	4.83	64
CONSIDER	2. PERFORM ALGEBRA	12	9	22	15	6	3.09	64
CONSIDER	3. PERFORM GEOMETRY	18	15	19	8	4	3.55	64
CONSIDER	4. PERFORM TRIGONOMETRY	27	11	11	10	5	3.70	64
YES	5. READ & INTERPRET SHOP SPECIFICATIONS	54	6	3	1	0	4.77	64
YES	6. USE MEASURING & INSPECT TOOLS	57	6	1	0	0	4.88	64
YES	7. READ BLUEPRINTS	55	7	2	0	0	4.83	64
YES	8. PERFORM BASIC MACHINE TOOL OPERATIONS	50	10	4	0	0	4.72	64
YES	9. KNOWLEDGE OF HIGH SPEED CUTTING TOOLS	25	20	14	4	1	4.00	64
YES	10. KNOWLEDGE OF CARBIDE CUTTING TOOLS	30	16	11	5	2	4.05	64
YES	11. FEEDS & SPEEDS	31	18	10	3	0	4.24	62
CONSIDER	12. TOOL GRINDING	21	17	16	5	4	3.73	63
CONSIDER	13. OPERATE NC MACHINES	10	11	19	6	8	3.17	54
	14. PROGRAM NC MACHINES	4	3	16	15	12	2.44	50
CONSIDER	15. OPERATE CNC MACHINES	17	8	12	9	5	3.45	51
	16. PROGRAM CNC MACHINES	6	6	15	11	11	2.69	49
	17. OPERATE GNC MACHINES	2	3	7	9	12	2.21	33
	18. PROGRAM GNC MACHINES	2	1	6	11	12	2.06	32
	19. OPERATE DNC MACHINES	2	2	2	10	10	2.08	26
	20. PROGRAM DNC MACHINES	2	1	2	11	10	2.00	26
	21. PROGRAM CAM SYSTEMS	4	1	4	9	12	2.20	30

TABLE B-6

ADVISORY COMMITTEE POTENTIAL (Shops Employing 10-49)

Interviewee	Title	Firm Name
		Crane Mfg. & Service Corp.
Al Seemann	Fabrication Superintendent	Bolens
Anthony Birong	Mgr. of Manufacturing	AAA Sales & Engineering
Bernie Metzger	Manufacturing Eng.	Bradley Corporation
Bob Ruggles	Plant Manager	Zierden Company
Bob Simpson	Vice President	Precision Screw Thread Corp.
Chris Faulhaber, Jr.	Mgr. of Personnel & Safety	Super Steel Products Corp.
Dave Rowe	Personnel Manager	Snap On Tools
Dell Fisher	Vice President	Marker Machine
Earl F. Herold	Machine Shop Supervisor	Milwaukee Faucets
Ed Nunemaker	Plant Mgr., Vice Pres.	Herker Screw Products, Inc.
Guy Hoppe	Lab Relations Mgr.	Aqua-Chem
Harold Krueger	Owner	Krueger Machine Co., Inc.
Howard Davison	Chief Engineering	Milwaukee Machine Products
Jack Lang	Tool Room Supervisor	Delco Electronics
James Jorgerson	President	Milwaukee Press
Joe Williams	Owner	Williams Mfg.
Joe Zankl	Plant Superintendent	Modern Equipment Co.
Ken Mahuta		Wesley Tool & Die
Mickey Faucher	Superintendent	Ullmann, Inc.
Norm Scheer	Plant Superintendent	Galland Henning Nopak
Richard Pettzer	Toolroom Foreman	Surinak Mach.
Robert Hron	President	Barton Products Corp.
Terry Knight	Sales Manager	Accurate Automatic Parts, Inc.
Thomas Stuckart	Manager, Manufacturing Eng.	Artos Engineering Co.
Wayne Hofrichter	Secretary of Company	Waller Machine

TABLE C-1

MACHINE TOOLS CURRENTLY IN USE (Shops Employing 50-99)

Abbreviation	Lathe	Mill	Turret	Screw	NC	GNC	CNC	DNC
AMPCO	4	9	19	10	1	0	4	0
Badger	6	15	5	20	8	0	3	0
Brig&Strat	14	23	0	0	0	0	5	0
CapitolEng	6	25	0	0	5	4	3	0
CarbonTool	3	2	0	0	8	1	2	0
Economy	6	6	5	22	0	0	0	0
FalkCorp	5	5	6	0	0	2	5	7
Gilman,Inc	6	12	0	0	1	2	3	0
MilGearCo	1	4	3	3	0	0	9	0
NatlManuCo	3	12	10	0	1	2	10	0
OilGearCo	9	12	14	3	2	0	10	0
OsterCorp	6	15	2	8	0	0	1	0
Rexnord,Inc	5	3	0	0	0	0	3	0
WIDrillCo	8	6	4	0	1	0	0	0
Total:	82	149	68	65	27	11	58	7

Note: See Table A-1 for description of column headings.

TABLE C-2

ESTIMATES OF MACHINISTS WORKING WITH NC (Shops Employing 50-99)

Abbreviation	Conv %	Comp %	Wkrs	Machinists	NC Machinists
AMPCO	95	5	57	54.15	2.85
Badger	90	10	70	63.00	7.00
Brig&Strat	90	10	80	72.00	8.00
CapitolEng	90	10	85	76.50	8.50
CarbonTool	60	40	55	33.00	22.00
Economy	100	0	55	55.00	0.00
FalkCorp	60	40	75	45.00	30.00
Gilman,Inc	85	15	50	42.50	7.50
MilGearCo	90	10	50	45.00	5.00
NatlManuCo	40	60	50	20.00	30.00
OilGearCo	89	11	80	71.20	8.80
OsterCorp	99	1	50	49.50	0.50
Rexnord,Inc	90	10	54	48.60	5.40
WIDrillCo	95	5	75	71.25	3.75
Total:	1,173	227	886	746.70	139.30

Note: See Table A-2 for description of column headings.

TABLE C-3

MACHINISTS WORKING WITH NC IN 5 YEARS (Shops Employing 50-99)

Abbreviation	Conv5 %	Comp5 %	Wkrs 5	Machinists	NC Machinists
AMPCO					
Badger	85	15	70	59.50	10.50
Brig&Strat	70	30	40	28.00	12.00
CapitolEng	50	50	100	50.00	50.00
CarbonTool	50	50	55	27.50	27.50
Economy	80	20	110	88.00	22.00
FalkCorp	40	60	100	40.00	60.00
Gilman,Inc	70	30	65	45.50	19.50
MilGearCo	85	15	70	59.50	10.50
NatlManuCo	20	80	67	13.40	53.60
OilGearCo	85	15	125	106.25	18.75
OsterCorp	80	20	40	32.00	8.00
Rexnord,Inc	90	10	54	48.60	5.40
WIDrillCo	80	20	50	40.00	10.00
Total:	885	415	946	638.25	307.75

Note: See Table A-3 for description of column headings.

TABLE C-4

NEW JOBS IN MACHINE SHOPS (Shops Employing 50-99)

Abbreviation	Wkrs	Wkrs 5	Retire	New	Special	Mltpl	Trg Y	Trg N
AMPCO	57		4	-53.00	0	1	1	0
Badger	70	70	10	10.00	0	1	1	0
Brig&Strat	80	40	4	-36.00	1	0	1	0
CapitolEng	85	100	4	19.00	1	0	1	0
CarbonTool	55	55	0	0.00	1	0	1	0
Economy	55	110	5	60.00	0	1	1	0
FalkCorp	75	100	0	25.00	0	1	1	0
Gilman,Inc	50	65		15.00	0	1	1	0
MilGearCo	50	70	5	25.00	0	1	1	0
NatlManuCo	50	67	5	22.00	0	1	1	0
OilGearCo	80	125	15	60.00	0	1	1	0
OsterCorp	50	40	13	3.00	0	1	1	0
Rexnord,Inc	54	54	10	10.00	0	1	0	1
WIDrillCo	75	50	7	-18.00	1	1	1	0
Total:	886	946	82	142.00	4	11	13	1

Note: See Table A-4 for description of column headings.
THESE PROJECTIONS ARE CONSERVATIVE In every case where the employer did not make a projection for future employment (Column Wkrs 5) the most conservative assumption of 0 was used.

TABLE C-5

SPECIFIC SKILL NEEDS ASSESSMENT FOR MACHINE SHOPS IN SOUTHEASTERN WISCONSIN
(Shops Employing 50-99)

	ITEM	5	4	3	2	1	MEAN	NUMBER
YES	1. PERFORM ARITHMETIC	12	2	0	0	0	4.86	14
CONSIDER	2. PERFORM ALGEBRA	3	3	1	4	2	3.08	13
CONSIDER	3. PERFORM GEOMETRY	4	2	2	5	1	3.21	14
	4. PERFORM TRIGONOMETRY	5	2	2	3	2	3.36	14
YES	5. READ & INTERPRET SHOP SPECIFICATIONS	8	3	2	1	0	4.29	14
YES	6. USE MEASURING & INSPECT TOOLS	10	3	1	0	0	4.64	14
YES	7. READ BLUEPRINTS	12	1	1	0	0	4.79	14
YES	8. PERFORM BASIC MACHINE TOOL OPERATIONS	10	2	2	0	0	4.57	14
CONSIDER	9. KNOWLEDGE OF HIGH SPEED CUTTING TOOLS	4	3	5	1	0	3.77	13
YES	10. KNOWLEDGE OF CARBIDE CUTTING TOOLS	5	5	2	1	0	4.08	13
CONSIDER	11. FEEDS & SPEEDS	5	4	3	0	2	3.71	14
CONSIDER	12. TOOL GRINDING	5	2	2	3	1	3.54	13
CONSIDER	13. OPERATE NC MACHINES	4	6	1	2	1	3.71	14
	14. PROGRAM NC MACHINES	2	1	2	2	5	2.42	12
CONSIDER	15. OPERATE CNC MACHINES	3	6	1	1	1	3.75	12
	16. PROGRAM CNC MACHINES	2	3	1	3	3	2.83	12
CONSIDER	17. OPERATE GNC MACHINES	2	2	0	2	1	3.29	7
CONSIDER	18. PROGRAM GNC MACHINES	2	2	0	2	2	3.00	8
	19. OPERATE DNC MACHINES	1	1	1	2	1	2.83	6
	20. PROGRAM DNC MACHINES	0	2	0	2	2	2.33	6
	21. PROGRAM CAM SYSTEMS	1	1	0	2	2	2.50	6

TABLE C-6

ADVISORY COMMITTEE POTENTIAL (Shops Employing 50-99)

Interviewee	Title	Firm Name
A. L. Momberg	Director of Manufacturing	Badger Meter
Bernie Nelson	Production Manager	Capitol Engineering
Bob Scholz	Manufacturing Manager	Economy Bushing
Charles Deisinger	Works Manager	Falk Corporation
David G. Morton	Vice President of Mfg.	Briggs & Stratton Corp.
Glenn Kneser	General Superintendent	Rexnord, Inc.
Jack Fellenz	Production Control	Carbon Tool & Manufacturing
Ken Lebal	Vice President	National Manufacturing Co.
Lothar Kinscher	Vice President-Manufacturing	Russell T. Gilman, Inc.
Patrick Martin	Plant Superintendent	Wisconsin Drill Head Co.
Robert Gleisner	Plant Manager	Oster-Division of Sunbeam Corp.

TABLE D-1

MACHINE TOOLS CURRENTLY IN USE (Shops Employing Over 100)

Abbreviation	Lathe	Mill	Turret	Screw	NC	GNC	CNC	DNC
AllenBrad	5	12	10	42	12	0	10	0
AO.Smith	25	30	3	0	2	0	1	0
Bucy-Erie	10	11	14	0	6	0	6	0
CustomProd	2	5	0	23	17	0	16	0
GenElecSys	3	18	18	7	4	0	39	0
HarleyCo	50	50	0	0	50	0	50	0
Harnisch	12	24	25	2	4	0	24	0
JohnsonCon	5	10	5	45	0	0	4	0
LadishCo	20	15	40	0	2	0	21	0
LouisAllis	21	15	19	1	2	0	10	0
MasterLock	7	18	0	45	0	0	2	0
MilElec	12	22	15	17	0	0	1	0
MilValveCo	4	6	15	12	0	1	6	0
ModMach	2	6	0	0	3	2	3	0
Superior	2	1	1	0	1	1	9	0
Teledyne	10	20	15	10	0	0	7	0
Total:	190	263	180	204	103	4	209	0

Note: See Table A-1 for description of column headings.

TABLE D-2

ESTIMATES OF MACHINISTS WORKING WITH NC (Shops Employing Over 100)

Abbreviation	Conv %	Comp %	Wkrs	Machinists	NC Machinists
AllenBrad	98	2	300	294.00	6.00
AO.Smith	99	1	200	198.00	2.00
Bucy-Erie	80	20	100	80.00	20.00
CustomProd	35	65	180	63.00	117.00
GenElecSys	90	10	275	247.50	27.50
HarleyCo	95	5	400	380.00	20.00
Harnisch	60	40	225	135.00	90.00
JohnsonCon	95	5	300	285.00	15.00
LadishCo	86	14	225	193.50	31.50
LouisAllis	75	25	125	93.75	31.25
MasterLock	97	3	130	126.10	3.90
MilElec	99	1	400	396.00	4.00
MilValveCo	80	20	150	120.00	30.00
ModMach	50	50	100	50.00	50.00
Superior	77	23	125	96.25	28.75
Teledyne	90	10	150	135.00	15.00
Total:	1,306	294	3,385	2,893.10	491.90

Note: See Table A-2 for description of column headings.

TABLE D-3

MACHINISTS WORKING WITH NC IN 5 YEARS (Shops Employing Over 100)

Abbreviation	Conv5 %	Comp5 %	Wkrs 5	Machinists	NC Machinists
AllenBrad	95	5	250	237.50	12.50
AO.Smith	98	2	200	196.00	4.00
Bucy-Erie	50	50	160	80.00	80.00
CustomProd	30	70	220	66.00	154.00
GenElecSys	70	30	275	192.50	82.50
HarleyCo	50	50	250	125.00	125.00
Harnisch	50	50	400	200.00	200.00
JohnsonCon	90	10	250	225.00	25.00
LadishCo	50	50	270	135.00	135.00
LouisAllis	65	35	107	69.55	37.45
MasterLock	97	3	130	126.10	3.90
MilElec	95	5	500	475.00	25.00
MilValveCo	60	40	150	90.00	60.00
ModMach	10	90	200	20.00	180.00
Superior	50	50	160	80.00	80.00
Teledyne	80	20	190	152.00	38.00
Total:	1,040	560	3,712	2,469.65	1,242.35

Note: See Table A-3 for description of column headings.

TABLE D-4

NEW JOBS IN MACHINE SHOPS (Shops Employing Over 100)

Abbreviation	Wkrs	Wkrs 5	Retire	New	Special	Mltpl	Trg Y	Trg N
AllenBrad	300	250	80	30.00	0	1	1	0
AO.Smith	200	200	10	10.00	0	1	1	0
Bucy-Erie	100	160	40	100.00	1	0	1	0
CustomProd	180	220	2	42.00	0	1	1	0
GenElecSys	275	275	25	25.00	0	1	1	0
HarleyCo	400	250	80	-70.00	0	1	1	0
Harnisch	225	400	25	200.00	0	1	0	1
JohnsonCon	300	250	75	25.00	0	1	1	0
LadishCo	225	270	60	105.00	0	1	1	0
LouisAllis	125	107	30	12.00	1	0	1	0
MasterLock	130	130	10	10.00	0	1	0	1
MilElec	400	500	50	150.00	0	1	1	0
MilValveCo	150	150	10	10.00	0	1	0	1
ModMach	100	200	10	110.00	0	1	0	1
Superior	125	160	15	50.00	1	0	0	1
Teledyne	150	190	50	90.00	0	1	1	0
Total:	3,385	3,712	572	899.00	3	13	11	5

Note: See Table A-4 for description of column headings.

THESE PROJECTIONS ARE CONSERVATIVE. In every case where the employer did not make a projection for future employment (Column Wkrs 5), the most conservative assumption of 0 was used.

TABLE D-5

SPECIFIC SKILL NEEDS ASSESSMENT FOR MACHINE SHOPS IN SOUTHEASTERN WISCONSIN
(Shops Employing Over 100)

	ITEM	5	4	3	2	1	MEAN	NUMBER
YES	1. PERFORM ARITHMETIC	13	2	1	0	0	4.75	16
	2. PERFORM ALGEBRA	2	1	3	5	4	2.47	15
CONSIDER	3. PERFORM GEOMETRY	4	3	3	2	3	3.20	15
CONSIDER	4. PERFORM TRIGONOMETRY	5	1	2	4	3	3.07	15
YES	5. READ & INTERPRET SHOP SPECIFICATIONS	15	1	0	0	0	4.94	16
YES	6. USE MEASURING & INSPECT TOOLS	15	1	0	0	0	4.94	16
YES	7. READ BLUEPRINTS	15	1	0	0	0	4.94	16
YES	8. PERFORM BASIC MACHINE TOOL OPERATIONS	12	2	2	0	0	4.63	16
CONSIDER	9. KNOWLEDGE OF HIGH SPEED CUTTING TOOLS	5	4	5	0	2	3.63	16
YES NA	10. KNOWLEDGE OF CARBIDE CUTTING TOOLS	8	6	2	0	0	4.38	16
YES	11. FEEDS & SPEEDS	4	8	4	0	0	4.00	16
CONSIDER	12. TOOL GRINDING	3	2	8	3	0	3.31	16
YES	13. OPERATE NC MACHINES	10	2	2	1	0	4.40	15
	14. PROGRAM NC MACHINES	0	2	4	2	5	2.23	13
YES	15. OPERATE CNC MACHINES	9	4	0	3	0	4.19	16
	16. PROGRAM CNC MACHINES	0	3	3	3	5	2.29	14
CONSIDER	17. OPERATE GNC MACHINES	4	1	2	3	1	3.36	11
	18. PROGRAM GNC MACHINES	0	1	3	2	2	2.38	8
CONSIDER	19. OPERATE DNC MACHINES	3	2	0	2	1	3.50	8
	20. PROGRAM DNC MACHINES	0	0	3	3	2	2.13	8
	21. PROGRAM CAM SYSTEMS	0	0	2	3	3	1.88	8

TABLE D-6

ADVISORY COMMITTEE POTENTIAL (Shops Employing Over 100)

Interviewee	Title	Firm Name
		Harley Davidson Motor Co.
Al Hammond	Corp. Mgr. of Mfg. Eng.	Milwaukee Electric Tool Corp.
Art Laabs	Mgr. of Manufacturing	Milwaukee Valve Co., Inc.
C. S. Janiszewski	Vice President of Operations	Superior Die Set
Duane Buchholz	Mgr., Industrial Engineering	Louis Allis Company
H. Britsch	Superintendent-Finishing Shops	Bucyrus-Erie Company
John P. Malloy, Jr.	Vice President, Sales & Eng.	Modern Machine Works
Juergon Lucka	Superintendent	A. O. Smith
Pete Callison	Tool Room Supervisor	Master Lock
Rudy Bader	Superintendent, Machining	Harnischfeger Corp.

APPENDIX 1

COMPANIES (WITH ABBREVIATIONS) AND INTERVIEWERS (Shops Employing Less Than 10)

Abbreviation	Firm Name	Interviewer
AbbotMach	Abbot Machine Company	Leroy Mersenski
Adelmeyer	Adelmeyer Tool, Inc.	Don Marlow
AlboCorp	Albo Corporation	Robert Yearling
ApolloMach	Apollo Machine, Inc.	Richard Hartzheim
BannerTool	Banner Tool & Eng. Corp.	Richard Hartzheim
Bostrom	Bostrom	John Miller
Chilton	Chilton Union	Gordon Fabian
CustomInc	Custom Tool Welding, Inc.	Don Marlow
DingsCo	Dings Company	Claude Klein
E-ZPainter	E-Z Painter	Richard Nowak
Elec-Mech	Electro-Mechano Co.	Edward Damro
FoxPt.Mfg	Fox Point Tool & Mfg.	Robert Yearling
G-PManufac	G-P Manufacturing, Inc.	Claude Klein
GenMachCo	General Machine Co.	Bill Chars
GenScrew	General Screw Products, Inc.	Robert Yearling
Germantown	Germantown Machine Works	Don Marlow
HeilComp	Heil Company	Richard Nowak
Kay-Bee	Kay-Bee Machine Products, Inc.	Don Marlow
KnuthMach	Knuth Machine & Tool Corp.	Robert Boyle
L-WMachine	L-W Machine Products, Inc.	
MachineCraf	Machine Craft	Bill Chars
MagnumProd	Magnum Screw Products Corp.	Edward Damro
Milwest	Milwest Machine	Leroy Mersenski
MWM-Murphy	MWM-Murphy Diesel Co.	Claude Klein
NatMachSpe	National Machine Specialists	John Miller
Numetech	Numetech, Inc.	Bill Chars
O'Donn-Corr	O'Donnell-Corriere Corp.	Edward Damro
P&WMachine	P & W Machine Co., Inc.	Claude Klein
PawlakTool	Pawlak Tool & Mfg. Corp.	Robert Boyle
PemperEng	Pemper Engineering Co., Inc.	Edward Damro
Perfect	Perfect Screw Products	Leroy Mersenski
PerowTool	Perow Tool & Machining Co., Inc.	John Miller
QMC,Inc	QMC, Inc.	Bill Chars
Reliable	Reliable Gear Corp.	Edward Damro
RoseCo	Rose Company	Richard Hartzheim
SuperProd	Super Products Corp.	Bill Chars
TapeMach	Tape Machining Corp.	Bill Chars
VassilMach	Vassil Machine Products, Inc.	Claude Klein
W.AllisCo	West Allis Machine Co.	Leroy Mersenski
WESCO	WESCO Machine Products	Bill Chars
WIMachShop	Wisconsin Machine Shop Inc.	Bill Chars

COMPANIES (WITH ABBREVIATIONS) AND INTERVIEWERS (Shops Employing 10-49)

Abbreviation	Firm Name	Interviewer
A-PlusMach	A-Plus Machine Products	Gordon Fabian
AAASales	AAA Sales & Engineering	Leroy Mersenski
Accurate	Accurate Automatic Parts, Inc.	Bill Chars
AdvScrewPro	Advance Screw Product	Richard Hartzheim
AmerCanCo	American Can Co.	Richard Hartzheim
Aqua-Chem	Aqua-Chem	Robert Yearling
ArrowInd	Arrow Industries	Claude Klein
ArtosEngCo	Artos Engineering Co.	Richard Hartzheim
BartonProd	Barton Products Corp.	Robert Yearling
Bolens	Bolens	Robert Boyle
Bradley	Bradley Corporation	Edward Damro
CraneMfg	Crane Mfg. & Service Corp.	John Papatriantafyllou
Delco	Delco Electronics	Richard Nowak
Deltrol	Deltrol	John Miller
Denco	Denco Manufacturing	Bill Chars
Ditt-FreCor	Dittmore-Freimuth Corporation	Richard Hartzheim
Dynamic	Dynamic Tool & Design	John Miller
EntrustCo	Entrust Tool & Design Co., Inc.	Gordon Fabian
ErieMfgCo	Erie Mfg. Company	Leroy Mersenski
EST	EST Division of Leggett & Platt	Robert Boyle
Frantz	Frantz Machine Products	Gordon Fabian
FusionCo	Fusion Bearing Co., Inc.	Claude Klein
Galland	Galland Henning Nopak	Leroy Mersenski
GrobInc	Grob, Inc.	Robert Boyle
H&K,Inc.	H & K, Inc.	Bill Chars
HanelCorp	Hanel Corporation	Bill Chars
Harman	Harman Products, Inc.	Edward Damro
Herd&KlugCor	Herdeman and Klug Corp.	Richard Hartzheim
HerkerInc	Herker Screw Products, Inc.	Don Marlow
Inter T&E	Interstate Tool & Eng. Corp.	Richard Hartzheim
Kempsmith	Kempsmith	Leroy Mersenski
Koehring	Koehring Company	Robert Boyle
Krueger	Krueger Machine Co., Inc.	Gordon Fabian
Lakeside	Lakeside Bridge & Steel	Leroy Mersenski
Logeman	Logeman Brothers Co.	Gordon Fabian
MantelMach	Mantel Machine Products	Robert Yearling
MarkerMach	Marker Machine	Edward Damro
MasterMach	Master Machine	Gordon Fabian
MechIndus	Mechanical Industries	Gordon Fabian
MilFaucets	Milwaukee Faucets	Edward Damro
MilMach	Milwaukee Machine Products	Robert Yearling
MilParts	Milwaukee Parts	John Miller

COMPANIES (WITH ABBREVIATIONS) AND INTERVIEWERS (Shops Employing 10-49)

Abbreviation	Firm Name	Interviewer
MilPress	Milwaukee Press	Richard Nowak
ModEquipCo	Modern Equipment Co.	Robert Boyle
NatlScrew	National Screw Machine Products	Edward Damro
Perlick	Perlick Corporation	Richard Nowak
POW Mach	POW Machining	Bill Chars
PreScrewThd	Precision Screw Thread Corp.	Richard Hartzheim
Riverside	Riverside Mold & Die, Inc.	Gordon Fabian
SchmidtEng	Schmidt Eng. & Equip. Co. Ltd.	Claude Klein
ScrewMach	Screw Machine Products	Robert Yearling
SingerT&D	Singer Tool & Die	Don Marlow
SnapOnTool	Snap On Tools	Bill Chars
SquareD	Square D Company	Edward Damro
StanekTool	Stanek Tool Corp.	Richard Hartzheim
Starline	Starline Mfg. Co.	Edward Damro
SuperSteel	Super Steel Products Corp.	Robert Yearling
Sure-Way	Sure-Way Tool & Die	Gordon Fabian
SurinakMch	Surinak Mach.	Richard Hartzheim
UllmanInc	Ullmann, Inc.	Richard Hartzheim
WallerMach	Waller Machine	Gordon Fabian
WesleyT&D	Wesley Tool & Die	Don Marlow
Williams	Williams Mfg.	John Miller
Zierden	Zierden Company	John Miller

COMPANIES (WITH ABBREVIATIONS) AND INTERVIEWERS (Shops Employing 50-99)

Abbreviation	Firm Name	Interviewer
AMPCO	AMPCO Metal	Claude Klein
Badger	Badger Meter	Robert Yearling
Brig&Strat	Briggs & Stratton Corp.	Gordon Fabian
CapitolEng	Capitol Engineering	Richard Hartzheim
CarbonTool	Carbon Tool & Manufacturing	Don Marlow
Economy	Economy Bushing	Leroy Mersenski
FalkCorp	Falk Corporation	Don Marlow
Gilman,Inc	Russell T. Gilman, Inc.	Robert Boyle
MilGearCo	Milwaukee Gear Company	Robert Yearling
NatlManuCo	National Manufacturing Co.	Leroy Mersenski
OilGearCo	Oil Gear Company	Richard Nowak
OsterCorp	Oster-Division of Sunbeam Corp.	Robert Yearling
Rexnord,Inc	Rexnord, Inc.	Richard Nowak
WIDrillCo	Wisconsin Drill Head Co.	Edward Damro

COMPANIES (WITH ABBREVIATIONS) AND INTERVIEWERS (Shops Employing Over 100)

Abbreviation	Firm Name	Interviewer
AllenBrad	Allen-Bradley Co.	Richard Nowak
AO.Smith	A. O. Smith	Robert Yearling
Bucy-Erie	Bucyrus-Erie Company	John Papatriantafyllou
CustomProd	Custom Products Corp.	Don Marlow
GenElecSys	General Electric Medical Systems	Bill Chars
HarleyCo	Harley Davidson Motor Co.	Don Marlow
Harnisch	Harnischfeger Corp.	Edward Damro
JohnsonCon	Johnson Controls	Robert Yearling
LadishCo	Ladish Company	Richard Nowak
LouisAllis	Louis Allis Company	Gordon Fabian
MasterLock	Master Lock	Gordon Fabian
MilElec	Milwaukee Electric Tool Corp.	Don Marlow
MilValveCo	Milwaukee Valve Co., Inc.	Gordon Fabian
ModMach	Modern Machine Works	Richard Hartzheim
Superior	Superior Die Set	John Papatriantafyllou
Teledyne	Teledyne Wisconsin Motor	Claude Klein

SKILL SCARCITY

. . . results of a Harris Poll

Skill shortages facing the precision metalworking industry are directly related to the ups and downs of the business cycle, according to a survey of precision metalworking companies conducted by Louis Harris and Associates, Inc.

These ups and downs *"almost guarantee shortages of skilled employees in the precision metalworking industry during periods of rising business volume,"* Harris said at a press-conference reporting findings of his study. *"Because the recession forced a dramatic decline in the industry's employment of apprentices and trainees in the first half of 1982,"* Harris said, *"and because of the lengthy training periods required to bring new skilled employees into the work force, this study shows that as the industry's business picks up in the future, the supply of skilled employees available to the precision metalworking industry will almost surely be inadequate."*

The survey, sponsored by Sentry Insurance on behalf of the Task Force on the Skilled Trades Shortage, reveals that while total plant employment of skilled journeymen and machine operators fell only 4%, the number of apprentices and trainees fell by fully 18%.

Employers appear fully aware of the implications. *"Collectively, they would want to hire more than 36,000 more skilled employees than they think they could actually find if business were to return to the levels of 1977 and 1978. Because this study represents only a portion of the precision metalworking industry, the overall skilled employee shortage for the entire industry could be substantially higher."*

According to Harris, cyclical shortages of skilled labor in the precision metalworking industry could carry larger consequences as well. If, for example, the output of independent and captive metalworking shops is constrained by shortages of skilled employees when business is good, it may mean lead times for product delivery could be lengthened and product prices could be subject to upward pressure if wage rates increase. This could result in work being contracted to vendors outside the U.S. or in imports of machined products.

In addition to exploring the skills shortage, the study examined American's attitudes toward working in industries such as the precision metalworking industry.

"Americans," said Harris, *"attach no stigma to industrial employment, even as the economy is increasingly dominated by service industries. The recruiting priority for the industry is to persuade candidates that the precision metalworking trade is itself a highly specialized occupation, demanding rigorous training and providing rich rewards in terms of job satisfaction and security."*

The study, conducted from a stratified random sample of 800 companies in the industry and interviews with 2,500 adult Americans, 18 years or older, suggests that the industry should recruit apprentices more aggressively and during periodic slowdowns, *"provide its apprentices and trainees with some assurances of job security."* The study concludes: "Combined with appropriate changes in public policy, such measures (as those just mentioned) could go a long way toward relieving the cyclical skilled labor shortages the precision metalworking industry now faces."

Members of the Task Force on the Skilled Trades Shortage are American Die Casting Institute, American Machine Tool Distributors Association, American Metal Stamping Association, National Machine Tool Builders Association, National Tooling and Machining Association, National Screw Machine Products Association, Society of Manufacturing Engineers, Society of the Plastics Industry and Tool and Die Institute which together represent 32,000 companies employing approximately one million employees and producing $50 billion in sales annually.

The National Screw Machine Products Association's reaction to the Louis Harris survey was one of positive agreement. A founding member of the Task Force, NSMPA has been deeply concerned about the skilled trades shortage in the screw machine products industry.

Peter Wrenn, Hudson Screw Machine Products Company, Chicago, Illinois, one of two Association representatives to the Task Force, commented that, *"It's interesting to note that the screw machine products industry ranked the skilled trades problem as more important than any of the other six metalworking industries surveyed."* Wrenn went on to say the study pretty well confirmed what NSMPA has been thinking all along; the shortage of skilled people, while currently not a problem because of the severe recession, will be with us when business picks up.

"The industry is placed in a difficult position because of extreme swings in the business cycle. At the low end, we tend to lay off all but the most essential employees in order to survive the adverse business climate. When business picks up we scramble for training programs and trainees to accommodate increased business. However, we never catch up with the demand for skilled employees because of the long lead times necessary for training," Mr. Wren said.

Wrenn termed this a no win situation *"as long as we have business cycles and continue to train as we have in the past. The answer seems to be that we need a pool*

of qualified screw machinists available on a continuous basis. This will require significant changes in our educational system and will require more training by more companies in industry. The problem is further compounded by intense foreign competition, especially from the Japanese. We need a quality, skilled work force to compete in a world economy."

Richard Braun of R.J. Frisby Manufacturing Co., *(Elk Grove Village, IL)* NSMPA's other representative on the Task Force stated, *"In my opinion the survey results clearly show that a new approach is needed to recruiting and training young people in the screw machine industry. The study revealed that for individuals in households with incomes less than $25,000 and with a high school education or less the biggest, single most important employment issue is health and safety. Our recruiting programs must emphasize more clearly the type of work environment that exists today. Plants are clean, modern and safe—not like the 'sweat shop' environments of the past."* He went on to say more should be done to emphasize the challenge and opportunities that exist in the screw machine products industry for personal job satisfaction to the individual.

A surprise in the survey results was stress on the rigorousness and extensive training necessary to become a qualified screw machinist. In the past, the industry tended to downplay training so as not to turn off potential trainees. According to the survey, the industry's recruiting program should be similar to that used by the U.S. Marine Corps: *"we need a few good men and women."*

Frank McGinnis, NSMPA's Executive President feels that *"our Training Committee has been in existence for the past 25 years and has continuously produced training materials which include films, manuals, curriculums and tests. These efforts represent NSMPA's concern for the immediate problem of training people. NSMPA's participation and leadership on the Task Force represents the Association's commitment to the long term solution of providing adequate training to produce qualified, skilled employees."*

According to Peter Wrenn the next step for the Task Force is to examine results of the survey and develop workable long range solutions to the skilled trades shortage. The problem of skilled trade shortages will require extensive revision of vocational training as a viable alternative to college. *"Basically what the survey suggests is a revision of vocational training and in-house training programs to provide a larger more consistent pool of employees. This will be no easy task,"* Mr. Wrenn said.

(For more information on the Task Force or the Lou Harris Survey please write to Task Force On The Skilled Trades Shortage, 9300 Livingston Road, Fort Washington, Maryland 20744.)■

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These comments are from H. Britsch, Superintendent--Finishing Shops, Bucyrus-Erie Company.

COMMENTS

The needs naturally differ from company to company. The most important part of any type of machine tool operation in any shop is the setup, the basic rule of setting up a machine tool. The accuracy of the proper setup determines the success of high quality machining.

Tool knowledge is important, but most important is the treatment, care and handling of tools. The proper selection of handtools, wrenches, hammers, files, setup or step blocks, clamps, bolts, nuts, T-nuts, studs, etc. is never overstressed. Basic machine shop principles from housekeeping, efficient cleanup to the cleaning of files and storage of micrometers, verniers and other expensive gauges are missing or easily passed up. Companies, such as B-E, which invest millions in machine tools for gear cutting of very expense gears must depend on well trained operators with personal pride and interest in perfection which starts with those basic principles.

Too often we stress knowledge of algebra, programming, feeds, speeds and CAD/CAM over the basics without recognizing that the above are accelerated stages and should be practiced by only such employees who master the basics and practice these without question.

Most medium and large companies have Industrial Engineering departments which provide manufacturing with programs - proper tooling, tooling sequence, feeds, speeds and so on. This leaves only alternatives to the operator which must be reported to I.E. again. There are, however, small companies in which operators must program their operations. This, in my opinion, needs on-the-job training, since there are always big differences from control to control, system to system and machine tool to machine tool.

Quality and the operator responsibility toward quality is again low-keyed in most institutions - often treated as a stepchild but most important to the American industry. We are facing two big opponents in our shops. Request quality - you can get it - but only in an unreasonable time frame. Request a reasonable time limit and the product lacks quality, which leads back to knowledge of the basics, which includes all the points above.

To summarize my points, programming, CAD/CAM and cutting tool selection for NC, CNC or any other computerized machining system should and must be performed by industrial or manufacturing engineering departments or, for small companies, an employee with the responsibility of such, in order to control the use and lifetime of cutting tools in order to get the best for the company dollar.

Shop math, geometry, and trigonometry are more important than college algebra because the first three are needed for blueprint reading and interpretation.

Finally, at the end of each semester, a test or examination is needed. This must include written, verbal and practical tests, and performance, and could include (a) designing of a part, tool, etc.; (b) planning how to make it (manufacturing process) and reasonable time factor to make the part (costing) and should finally be judged by its quality and variances if this would be practiced with positive criticism in mind. The American machinist could be upgraded to compete with any competition because they would compete with each other for number one and would assure security for our future.

H. Britsch

APPENDIX 4

Minutes of the March 28, 1984, meeting of the Machine Shop, Tool and Die, and Numerical Control faculty.

The meeting was called to order at 1:00 p.m. by D. Marlow.

Present:

W. Miller

W. Adomat	R. Boyle	G. Fabian
R. Haiser	C. Klein	R. Lynch
D. Marlow	R. Nowak	R. Sliwicki
J. Papatriantafyllou		R. Yearling
W. Chars		

Excused:

E. Damro	E. Lecher	L. Mersinski

W. Chars assumed the chair of the meeting at 1:10 p.m.

The group made the following assumptions and approved the following recommendations.

Assumptions	Recommendations
	That
1. a) Society does not understand the role of metal cutting in manufacturing.	1. the title of the Machine Shop Department is to be changed to "Machine Tool Techniques".
b) Society has a misconception or is alienated from machine shop work.	
2. a) The Numerical Control Programmer, Industrial Engineer Technician, and the Mechanical Design Technician should have knowledge of machining operations.	2. room T110 is to be utilized for providing machine tool operation instruction for the students enrolled in Industrial Engineering Technician, Mechanical Design Technician, and Numerical Control

WHA

	Programming, and others as needed.
3. a) There is a lack of communication between the Administration and the faculty, and between faculty and faculty. b) The rapidly charging technology of today requires constant communication and coordination between administration and faculty and faculty and faculty to maintain an up-to-date curriculum.	3. a) the Administration authorize the Machine Tool Operation, Tool and Die Maker, and Numerical Control Departments the required time to meet at least once per four-week period. b) The meetings are to alternate between the a.m. and the p.m. c) An agenda is to be provided with the meeting announcement. d) R. Nowak volunteered to be Chairman of the group.
4. a) The purchase of state of the art conventional or CNC equipment for instruction in the above departments is exorbitant. The equipment, however, is required for effective machine tool operator, and tool and diemaker skills training. b) There is a need for cooperation between MATC and the industrial community for the school to acquire the appropiate machine tools or equipment for the necessary skills training.	4. a) the faculty be authorized to solicit the industrial community for machine tool or other donations to be made to the MATC Foundation. b) The faculty as a group are to be offered the opportunity to evaluate and make recommendations on the disposition and/or use of the donations offerred.
5. a) This group previously recommended the inclusion of CNC machine tool operation in the machine shop curriculum.	5. a) Two CNC Mill/Drill Machine Operator courses are to be developed for inclusion in the Machine Tool Operators

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curriculum. One course is to be in Vertical Machines and one in Horizontal Machines.

The pre-requisites for these courses are to be two courses in Milling Machine Operation.

b) Two CNC Turning Machine Courses are to be developed for inclusion in the Machine Tool Operators curriculum. One course is to be in a two axis turning machine and one to be in a turning center.

The pre-requisites for these courses are to be two courses in Turning Machine Operations.

6. a) A related CNC course is needed to instruct the student in basic CNC topics, such as terminology, reading tape, if necessary, and understanding the format of the specific machine tool being operated.

6. a) A 300 series introductory course for CNC is to be developed and added to the Machine Tool Operators curriculum.

b) This course is to be a requirement for graduation from the Machine Tool Operators Program.

c) The pre-requisite for this course is to be 2 semesters of turning machines and concurrent registration in milling machines.

d) The following faculty volunteered to serve on the CNC subcommittee to develop outlines and curriculum for the CNC Machine Tool Operations and Related courses.

W. Adomat R. Boyle
G. Fabian R. Yearling
J. Papatriantafyllou

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W. Adomat is willing to serve as chairman of the committee.

7. An advisory committee from the survey respondents that expressed an interest in serving on such a committee needs to be selected.

7. D. Marlow volunteered to serve as coordinator for selecting an advisory committee.

The meeting was adjourned at 3:15 p.m.

Respectfully submitted,

Wilmer H. Adomat

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